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ENERGY IN THE LEAST DEVELOPED COUNTRIES

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ENERGY IN THE LEAST DEVELOPED COUNTRIES

Introduction

The least developed countries (LDC) are generally poor in natural resources, permanent debtors, and have weak economies. They are highly vulnerable to circumstances beyond their control, such as natural disasters, droughts, desertification and geographic isolation. In addition, the lack of capital, scarcity of skilled manpower, and shortage of infrastructural technologies, combined with growing population, hinder any appreciable economic development.

During the 1970s and 1980s, the group of LDC's, which currently includes 42 countries, has had to cope with increasing debt burdens to meet their growing energy requirements. Although lower oil prices since 1986 have reduced the burden of energy imports. However, in the longer-term LDCs will have to satisfy a larger share of their energy needs through accelerated exploration and development of their indigenous energy resources and improvements in the efficiency of energy use, especially electric power.

The least developed countries with a total population of over 400 millions - about half that of the developed market economies - have a *per capita* income of just over $250

READEX

per year, which is equivalent to about 0.2 per cent of that of the developed market economies, or 8 per cent of per capita income worldwide.1/

Commercial primary energy consumption in the least developed countries amounted to 17.8 million tons of oil equivalent (toe) in 1987. This is approximately 0.26 per cent of worldwide consumption, or about equal to the consumption of Switzerland. Per capita commercial energy consumption of the LDC's was 44 Kg of oil equivalent, as compared to 1348 Kg for the world and 4354 Kg for the developed market economies.2/

These countries continue to depend heavily on traditional forms of energy such as fuelwood, charcoal and bagasse. Such energy sources provide about 77 per cent of LDC's total energy consumption, as compared to 25 per cent for all developing countries in 1986.

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Energy Consumption

Least developed countries account for a minute but slightly growing share of the world's commercial energy consumption (See Table 1). During the 1970s, their demand for commercial energy grew at over 5.3 per cent a year, and their consumption of oil rose at approximately the same rate. Following the oil price increase of 1979-80 and the subsequent economic recession, growth in commercial energy consumption fell slightly to about 5 per cent per year during 1981-86. Oil consumption remained almost stagnant, owing to foreign-exchange constraints as well as to development of alternative domestic energy sources. Between 1980 and 1987, the average annual increase in natural gas consumption was maintained at approximately 20 per cent, or about 7 times the rate worldwide. However, after the sharp decline in oil prices in 1986, oil consumption in these countries increased by about 9 per cent in 1987.

The share of oil in total commercial primary energy consumption of LDC's continues to drop. It declined from 85 per cent in 1970 to 77 per cent in 1980, and to 66 per cent in 1987. This shift in relative shares was due to significant growth in the share of natural gas, from 2 per cent in 1970 to 28 per cent in 1987. However, as of 1987 natural gas was used in only 4 countries out of the 42 least

developed countries. These were Afghanistan, Bangladesh, Myanmar, and Rwanda. On the other hand, oil accounted for more than 80 per cent of total commercial primary energy consumption in 29 countries. 15 of these countries depended on oil for 100 per cent (Burkina Faso, Cape Verde, Chad, Comoros, Democratic Yemen, Djibouti, Equatorial Guinea, Gambia, Guinea-Bissau, Kiribati, Maldives, Sierra Leone, Somalia, Vanuatu, and Yemen Arab Republic) The shares of coal and primary electricity (mainly hydropower) accounted for only 2.3 and 4.0 per cent, respectively.

Table 1: Commercial Primary Energy Demand in the Least Developed Countries

(thousands of tonnes, oil equivalent)

	1970	1980	1987
Total commercial primary energy use	7530	12428	17820
Oil	6424	9521	11801
Natural gas	159	1461	4900
Coal	725	565	403
Primary electricity	222	881	716

Source: Energy Statistics Yearbook (N.Y. : United Nations), various issues

In 1987, net energy imports in LDC's amounted to 10.9 million toe and accounted for 61 per cent of their total commercial energy consumption. Energy imports contributed to more than 90 per cent of consumption in 28 countries. 21 of these countries depended on imports for 100 per cent. Only two countries (Afghanistan and Benin) were net energy exporters.

The amount of energy consumed per unit of economic output (i.e. energy consumption divided by real GDP) is an indication of the intensity of energy use. In turn, trends of energy intensity largely reflect the level of economic development, structure of the economy, existing technologies and energy mix.

Long-term analysis of energy consumption in all countries leads to the following conclusions: at lower levels of economic development, the amount of energy used to produce each unit of output is generally low and tends to rise as the economy heads towards industrialization. On the other hand, at an advanced stage of industrialization, there is a tendency for the energy intensity growth to slow down after more energy-efficient technology, and improved process and equipment design become available.

Trends of energy intensity of the LDCs conform to this pattern.

Energy intensity trends of all countries generally conform to this pattern. In least developed countries as well as in developing countries as a whole long-term trends of energy intensity are rising while those of the industrialized countries are declining. Between 1970 and 1987, energy intensity in LDC's increased by 50 per cent from 0.8 barrels of oil equivalent per $1000 of real GDP (boe/$1000) to about 1.2 and in all developing countries it rose from 3.0 boe/$1000 to 4.1. Meanwhile, in the developed market economies and in Eastern Europe and the USSR, energy intensity declined by 2.7 per cent and 17 per cent, respectively during the same period.

Oil and Natural Gas

With increasing urbanization and industrialization, the LDCs consume growing amounts of commercial energy, especially petroleum. Given their inadequately diversified energy infrastructure other forms of energy such as natural gas or electricity cannot be readily substituted for petroleum. Although it is clearly recognized that the oil and natural gas exploration and development programmes must continue to be developed, there are major obstacles. Limited resources, inadequate sectoral infrastructure, together with incomplete geological and geophysical data on sedimentary formations, made it difficult to plan and develop exploration programmes. Adequate geoscientific data and information would stimulate the interests of the international oil companies which have the technical expertise and the vast financial resources required to find and exploit the oil and natural gas resources in the LDCs.

Production and Reserves

Among the LDCs, only 5 countries produced oil in 1989 (Bangladesh, Benin, Democratic Yemen, Myanmar and the Yemen Arab Republic), and commercial production of natural gas occurred in Afghanistan, Bangladesh and Myammar only. (Table 2). However, with the exception of the Yemen Arab Republic, the rest of the producing countries were net importers of oil.

Moreover, as can be seen in Table 3 for oil and gas reserves in those countries, only Democratic Yemen, Sudan and the Yemen Arab Republic have prospects for any significant increase in oil production in the near future.

Table 2 : Crude Oil Production in the LDCs

(thousand of barrels)

Country	1970	1980	1985	1986	1987	1988	1989
Bangladesh	0	44	161	168	183	329	329
Benin	0	0	2379	2665	2555	1679	1643
Democratic Yemen	0	0	0	0	...	4563	4500
Myanmar	5825	11381	11972	10439	7358	5475	4380
Yemen Arab Republic	0	0	0	2577	6570	58364	64240
Total	5825	11425	14512	15851	16666	70410	75092

Sources : DIESA of the United Nations Secretariat based on Energy Statistics Yearbook, 1982 and 1987 (United Nations publications, Sales Nos. E.F. 84.XVII.4 and E.F. 88.XVII.3) and crude oil production statistics for 1988 and 1989, Oil and Gas Journal, 26 December 1988 and 25 December 1989.

Table 3 : Oil and Gas Reserves of the LDCs

(Oil = millions of barrels)
(Gas = billion cubic feet)

Country	1 Jan. 1980		1 Jan 1985		1 Jan. 1990	
	Oil	Gas	Oil	Gas	Oil	Gas
Bangladesh	0	8000	0	7000	0.5	12 360
Benin	0	0	100	...	100	...
Democratic Yemen	0	0	...	...	3380	...
Mozambique	-	-	-	-	-	2290
Myanmar	25	135	28	170	52	9430
Somalia	-	-	-	-	-	210
Sudan	-	-	...	...	300	3000
Tanzania	-	-	-	...	-	4100
Yemen Arab Republic	0	0	0	0	1000	5500

Sources : Oil and Gas Journal, various issues.

Exploration and Development

Activity in all phases of exploration and development continually declined in the LDCs during the period 1982-1988 with the exception of those countries with crude oil production. This largely reflected a general slowing in the pace of exploration by international oil companies as well as the early relinquishments of acreage considered unprospective in view of the decline in oil prices. The sharpest decline in exploration activity took place in the LDCs compared to other developing countries, especially in those African countries with unproven petroleum potential. In these, only three exploratory wells were drilled in 1988, one in Equatorial Guinea and two in Somalia, and all proved to be dry.

In the Table 4 below, is a summary of the licensed acreage, exploration and development activities during the period 1982-1988 in the LDCs.

Exploration acreage under license in the LDCs countries continued to decline, with the total area down by about 8 per cent in 1988 from the previous year, continuing a downward trend in which overall licensed acreage declined by about 42 per cent between 1984 and 1988. However, licensing activity continued to take place during 1989 in several of the LDCs with

awards announced or acreage opened for bids. Myanmar reported onshore exploration concessions for the first time and exploration rightholdings increased in Somalia and Democratic Yemen, while in Mali and Sierra Leone all licensed acreage has been relinquished. The sustained level of total number of exploratory wells drilled shown in Table 4 was largely due to the significant increase in exploration intensity in the Yemen Arab Republic. Also the rapid rise in the rate of change of development drilling was mainly the result of development well completions in the Yemen Arab Republic, where oil production and export began in the later part of 1987.

Of particular note was the drastic decline in seismic exploration activity, declining from 33,245 line-km in 1982 to 8913 line-km in 1987, a decrease of 73 per cent. In 1988 it increased to 17,700 line-km, about half the level of 1982.

Table 4 : Exploration and Development Indicators
In the LDCs (1982-1988)

Year	Licensed Area (1000sq-km)	Seismic Activity (line-km)	Exploratory drilling 1/ (no. of wells)	Development drilling 1/ (no. of wells)
1982	1717.8	33245	34	6
1983	1274.2	31643	29	5
1984	2399.4	22912	19	8
1985	2390.3	21586	31	16
1986	2240.3	16865	20	24
1987	1505.9	8913	31	39
1988	1383.9	17700	35	57

1/ Excluding Myanmar, as correct information on the number of exploratory and development wells drilled was not readily available.

Source : World Petroleum Trends, 1989, Petroconsultants (U.K.) Ltd.

In those LDCs where hydrocarbon exploration has been taking place, the intensity of activities in most phases of exploration, licensed acreage, seismic surveys, exploration and development drilling, declined towards the end of the period 1982-1989. The decline in exploratory drilling was significant considering that there has been no commercial discoveries in those LDCs. Exploration drilling must be maintained in order for those LDCs to further evaluate the potential of their hydrocarbon resources.

Considerable amounts of geological and geophysical data have been generated in those LDCs from the past and ongoing exploration activities. It is necessary to establish or to re-organise geological and geophysical data banks and to further develop institutional bases of this strategic sector. The beginning step in the determination and localization of areas with hydrocarbon potential is essentially an inventory of geological facts and the estimation of economic parameters. Those data are indispensable in order to promote acreage for exploration, stimulate the interest of the international oil companies and attract new investments.

Coal

Only eight LDCs have identified coal resources and seven of them produce coal. Their production rates varied during the past decade. Mine production of coal rose sharply during the 1970s in Botswana and continued to rise during the 1980s. While in Mozambique current coal production was about 10 per cent of the production level of 1980, a drastic decline due largely to the continuing civil strife in that country. Coal production in Malawi also showed a steady decline in the 1980s, while most other countries have either sustained their production levels or have had marginal increases (Table 5).

The estimates of coal resources for some countries (Table 6) includes some coal that is technically accessible, but could only be produced at costs far in excess of prices likely to be obtained within the forseeable future.

Table 5 : Production of Coal and Lignite in the LDCs:

(thousands of metric tons)

Country	1970	1980	1984	1985	1986	1987
Afghanistan	164	145	148	151	160	167
Botswana	12	360	396	432	444	576
Mozambique	351	400	40	35	4	43
Myanmar						
Coal	11	38	44	43	51	46
Lignite	0	11	43	43	47	35
Niger	0	0	55	61	50	65
United Republic of Tanzania	3	4	3	4	4	3
Total coal	541	947	686	726	713	900
Total lignite	0	11	43	43	47	35

Source : DIESA of the United Nations Secretariat based on Energy Statistics Yearbook, various issues.

Table 6 : Estimated coal reserves in the LDCs
(million metric tons)

Country	Proved amount in place	Proved recoverable reserves	Type
Afghanistan	112	66	Bituminous
Bangladesh	1054	...	"
Botswana	7000	3500	"
Malawi	25	12	"
Mozambique	240	240	"
Myanmar	5	2	Bituminous/ sub-bituminous
Niger	45	...	
Tanzania	304	200	Bituminous

Source : World Energy Conference, Survey of Energy Resources, 1983.

In Afghanistan, mine production of coal increased steadily during the 1980s and has apparently regained the level of production of the early 1970s, having produced about 167,000 tons in 1987.

Total proved recoverable coal reserves in Botswana amount to some 3.5 billion metric tons, with proved reserves in place estimated at twice that amount. Botswana has the second largest deposits of coal in Africa. Production of coal in Botswana increased from about 12,000 tons in 1970 to about 576,000 in 1987.

The prospects of most of the coal deposits in Malawi were considered to be low, in view of the coal quality, seam thickness and continuity. As further detailed analysis of the coal deposits was necessary before development of a priority investment programme in this sector, exploration was intensified in the southern part of the country, particularly at Lengwe and Mwabvi, where inferred reserves were put at about 10 million tons and coal quality indicators were above average compared to deposits in other parts of the country.

Malawi's coal reserves, measured, indicated and inferred were established at about 807 million tons. With the disruption in the supply of coal from Mozambique and the rapid increase in coal import costs from Zambia and Zimbabwe, a coal mine was opened at Kaziwiziwi, in the northern part of the country in 1985, and was currently substituting some 30 per cent of the 40,000 tons consumed by Malawi industries, mainly as kiln fuel in the manufacture of cement. Mineable coal in this mine was reportedly estimated at only 200,000 tons.

In Mozambique, coal production was a fraction of the level in the late 1970s due to the severance of transport links from the coal mines. Production peaked in 1980 and 1981 at about 400 000 tons and declined to about 40,000 tons in 1987. A major expansion in coal production was being investigated to an annual level of 6 million tons of saleable

coal in two stages of 3 million tons. Implementation of those plans depended on the restoration of peaceful conditions in the country and progress in arranging the huge amounts of finance for capital investments in new mines, rehabilitation and upgrading of railway and port facilities.

Myanmar's production of sub-bituminous coal from the Kalewa coal mine declined to about 46,000 tons in 1987 after having produced a historical high of about 51,000 tons in 1986. Lignite production from the opencast Namma mine was reported as 35,000 tons in 1987 having declined from 47,000 tons in 1987.

Total mine production of coal in Niger was estimated at about 65,000 tons in 1987, having increased two-fold from about 30,000 tons in 1981. The coal was used for electricity generation at the steam plant in Anon Arare.

Although Tanzania's proved recoverable coal reserves stood at about 200 Mt, current saleable coal production from the Ilima Colliery was estimated at about 3,000 t/y only. The World Bank has funded a project to expand the capacity of the colliery. Included in the project also was an exploratory drilling programme followed by a feasibility study to establish an open coal mine at Kabulo ridge. With assistance from China, an underground mine was to be constructed at Kiwira, to establish a coal-fired power station.

New and Renewable Sources of Energy

The assessment of future energy demand in least developed countries presented later involves only commercial energy. However, fuelwood and other biomass account for the bulk of household energy in most of these countries. Moreover, in some of African LDC's, as high as 90 per cent of total energy consumption is provided by non-commercial fuels. This poses an ever-greater pressure in a progressively deforested local environment. Rural fuelwood appears to be continuously collapsing despite the steady migration of rural population to urban cities. Today, nearly 80 per cent of the population in the least developed countries lives in rural areas where the adverse effects of desertification and deforestation are leading to an increasingly scarce fuelwood supplies.3/

The pattern of energy use in the region of the Southern African Development Co-ordination Conference (S.A.D.C.C.) is probably indicative of that existing in African LDC generally. The first comprehensive analysis of S.A.D.C.C.'s energy balance showed that fuelwood comprised about 80 per cent of the region's total final energy use in 1985, oil products accounted for about 10 per cent, coal for 6 per cent, and electricity for 4 per cent. The analysis also revealed other interesting aspects of fuelwood's role in

these countries' energy position. For example, people's primary uses of trees in the region are to provide wood for construction, food, medicine, tools, cattle fodder, and many other non-energy related purposes. Broadly speaking, wood for fuel is in the nature of a residue after these other needs have been met. Also, fuelwood shortages in the region do not exist at the national level (with the exception of Lesotho), but rather are highly localized. Such insights, coupled with the generally disappointing results of conventional forestry interventions in the past, suggest a possible need to rethink the instruments and foci of policy intervention relative to the fuelwood problem in the region.4/

Electricity

Electricity demand in the least developed countries (LDC) was about 20.2 billion kilowatt-hours (KWH) in 1987 (the last year for which comprehensive data are available), i.e., about 51 KWH per capita. The latter figure compares with approximately 500 KWH for all developing countries and 5000 KWH for Europe. Annual per capita power use among the LDC ranged from about 10 KWH in Chad to 460 KWH in Djibouti. Electricity intensity - the ratio of electricity use to G.D.P. (in U.S. dollars of 1980 purchasing power) - is about 0.223 KWH per dollar for the LDC. The developing countries as a whole exhibit an electricity intensity of well over one kilowatt hour per dollar.

(Table 7 presents the salient features of electricity demand and supply in the LDC in 1987).

Several factors are involved in the wide disparity between the LDC and other developing countries in terms of electricity use: average household income; the degree of urbanization; the structure of aggregate production; and, the extent of "electrification" of the society, i.e., the percentage of households which have been linked to the local electrical grid. Latin America, which has the highest per capita electricity use among major developing country

Table 7: Electricity in the Least Developed Countries

	Production		Utilization			Usage	
	Capacity	Production	rate	Imports	Exports	Total	per capita
			Quantities				
	(10^6KW)	(10^9KWH)	(%)	(10^9KWH)	(10^9KWH)	(10^9KWH)	KWH/per capita
1973	3.53	8.41	27.2	0.309	0.463	8.26	29.0
1980	6.78	26.70	45.1	0.578	10.700	16.60	48.7
1987	9.16	20.20	25.1	1.250	0.887	20.50	50.6
			Growth rates				
	(%/yr)	(%/yr)		(%/yr)	(%/yr)	(%/yr)	(%/yr)
1973-80	9.8	18.0		9.4	56.7	10.5	7.7
1980-87	4.4	-4.0		11.6	-30.0	3.1	0.5
1973-87	7.1	6.4		10.5	4.8	6.7	4.1

Source: Energy Statistics Yearbook (N.Y: United Nations, various issues)

regions, has the highest level of electrification, with electrical power available to nearly 80 per cent of all households. By contrast, in developing Africa, which has the lowest per capita usage, only a quarter of all households are connected to electricity grids.

Electrical power demand in the LDC has grown relatively slowly over the last two decades, about 6.7 per cent per year on the average, compared to 8.2 per cent annually for all developing countries. (Power usage in the developed market economies has increased at 2.9 per cent per year over the same period but from a much higher base) On a per capita basis, electricity use in the LDC rose at an average annual rate of only 4.1 per cent over the period.

The price of oil is an important element in the cost of electricity generation in the LDC group. In most of these countries oil fired electrical generating plants form a significant percentage of total generating capacity, and, in 27 of the 42 LDC, oil burning facilities are employed exclusively. During the 1973 to 1980 upswing in the most recent oil price cycle, consumers of electricity in the LDC were, for the most part, shielded from the impact of rising international oil prices, and demand for power rose over ten per cent per year, on the average, during those seven years.

However, after the 1979-80 oil price increase, electricity tariff rises in the LDC became more frequent. These tariff increases, plus delays in passing on to final consumers the benefits of declining oil prices since 1981, have retarded electricity demand growth in the LDC during the 1980s. In the last few years, the lingering effects of past oil prices rises on power demand have been reinforced by the extremely slow rate of income growth in the LDC. As a result of these factors, electricity demand growth in the LDC dropped precipitously to a little over three per cent annually during the 1980 - 1987 period.

Electricity supply in the LDC is provided mainly by indigenous generating capacity. Roughly 9.2 million kilowatts (KW) of electricity generating capacity exist in these countries. About 57 per cent of this capacity is thermal (i.e., using oil, natural gas, or coal to fire boilers to produce steam to run generators), and 43 per cent is hydroelectric. As noted above, 27 LDC rely exclusively on oil-fired generating plants. There are no nuclear power plants in the LDC. This production capacity generated approximately 20.2 billion KWH of electrical power in 1987, a capacity utilization rate of only about 25 per cent. A great deal of generating capacity is technically obsolete and inefficient. Corresponding utilization rates for the developing countries as a whole and for the developed market economies are about 50 and 80 per cent, respectively.

Generating capacity in the LDC grew by 7.1 per cent annually over the 1973 to 1987 period, whereas electricity output expanded by 6.4 per cent per year during the same period, as the capacity utilization rate declined from 27 to 25 per cent. Whereas thermal capacity grew at an average annual rate of about 6.6 per cent in the LDC during both the 1973-80 and 1980-87 periods, hydroelectric capacity, after expanding at a 13.8 per cent annual rate during the first seven years, increased by only 2.0 per cent per year during the second.

There is a significant international trade in electricity involving LDC, especially in Africa. Thus, Benin, Burundi, Mozambique, Niger, Bwanda and Togo import quantities of power which are important shares of their domestic power usage, and Uganda exports about 16 per cent of its power output. In Asia, Bhutan and Nepal are (net) importers of electricity while the Lao Peoples Democratic Republic is a substantial exporter of electricity. Overall, the LDC imported 1.25 billion KWH and exported 0.887 billion KWH of electrical power in 1987.

The primary reason for the sharp cycle in LDC electrical power exports over the late 1970s and early 1980s is found in the foreign trade of Mozambique. Table 8 shows the evolution of the exports of electricity by the LDC as a whole and by Mozambique in particular from 1973 to 1987. It

is clear that the exports of the group largely mirror those of that single country over that period. The build-up and decline in the exports of Mozambique, in turn, reflect the operations of the Cahora Bassa hydroelectric project. Acts of sabotage and attacks on the local populace by armed bands have severely disrupted activities at that facility since the early 1980s.

Table 8: Evolution of the Electrical Power Exports of the Least Developed Countries

(10^9 KWH)

	All least developed countries	Mozambique	Other least developed countries
1973	0.463	-	0.463
1974	0.455	-	0.455
1975	0.437	-	0.412
1976	1.620	1.210	0.407
1977	4.690	4.230	0.458
1978	7.370	6.920	0.448
1979	11.300	10.400	0.954
1980	10.700	9.660	1.060
1981	3.590	2.660	0.926
1982	3.130	2.150	0.981
1983	5.950	5.030	0.922
1984	1.440	0.505	0.938
1985	0.970	0.100	0.870
1986	0.891	-	0.891
1987	0.887	-	0.887

Source: Energy Statistics Yearbook (N.Y. : United Nations, various issues)

Future Trends and Policies

Following an average growth rate of about 2.5 per cent per year in recent years, GDP in least developed countries is projected to increase at an average annual rate of 3.1 during 1991-2000. The projections of energy consumption in LDC's made in this report, will depend to a large extent on whether these forecasted GDP growth rates are achieved. Predicting energy demand, particularly over the longer-term is fraught with uncertainties. Therefore, the figures presented here are intended to be only an indication of a plausible development of energy demand at the aggregate level in least developed countries over the short to medium-term.

One method of forecasting energy demands is to estimate the income elasticity of energy demand (percentage change in energy consumption associated with one per cent change in GDP) based on a time series analysis of historical data. The assumption underlying this procedure is that there is a stable and close relationship between energy demand and GDP over time, so that energy consumption can be forecasted as a function of GDP.

The income elasticity in a developing country is usually higher than in a developed one, a reflection of the increased energy intensity required to accelerate upgrading of the standard of living and to provide energy-intensive heavy industries. The developing countries usually have an income elasticity greater than one, indicating that more energy is used to accompany marginal growth in real income.

Using historical data on energy demand and GDP, the income elasticity of energy demand in the least developed countries was estimated at 1.7 per cent. Based on this and on economic growth mentioned earlier, commercial energy consumption is projected to grow from 17.8 million toe in 1987 to 34.6 million toe by the year 2000 (see table 9). This is equivalent to an average growth rate of 5.2 per cent a year.

Table 9: Estimated future commercial energy demand in the least developed countries (Million ton of oil equivalent)

Year	1987	1990	1995	2000
Total primary commercial energy	17.82	20.7	26.7	34.6
Liquid hydrocarbons	11.8	13.4	16.7	20.8 - 416,000 b

Source: Department of International Economic and Social Affairs of t United Nations Secretariat.

Overall commercial energy demand will be met - as in the past - from a variety of sources.

Least developed countries will continue to be heavily dependent on oil at the end of the century although its share of total commercial energy consumption is projected to fall from 66 per cent in 1987 to 60 per cent by the year 2000. This drop will be offset by increases in the shares of natural gas and hydropower for electricity generation. Demand for oil would thus increase from 11.8 million toe in 1987 to approximately 21 million toe, or an average annual rate of about 4.5 per cent - that is at a higher rate than in the first half of the 1980s but lower than that of the 1970s. Projections of natural gas supply will depend on activities in a few large countries. Bangladesh alone accounted for nearly 27 per cent of the commercial energy in the least developed countries in 1987 and 67 per cent of natural gas consumed in these countries.

While the future holds promise for coal in the LDCs, there remained uncertainty surrounding the level of demand and the ability to develop and expand coal production particularly because of lack of appropriate infrastructure. The uncertainties also reflected issues such as the speed of economic and technological development in the LDCs and the social and political attitudes toward the environmental acceptability of coal.

A few of the LDCs are known to have substantial but hardly exploited potential for hydropower, which can be developed to meet growing electricity demand, provided that the sizeable investment required can be financed. On the other hand, all small islands, located at relatively great distances from mainland areas, may continue to have the same difficulty to obtain commercial fuels (other than oil) unless they can develop renewable sources of energy such as wind and solar power.

Unless LDC's can get access to affordable supplies of energy other than biomass or fuelwood, over the next decade, the economic and environmental consequences will be serious. So far, financial support provided by the international community has had only limited success in keeping pace with the growing energy needs of these countries. While the international oil market may remain relatively soft over the next few years, the longer-term outlook is for a gradual tightening of market conditions. This would have a far-reaching impact on the balances of payments of LDCs, since more imports of oil will be required to satisfy their energy needs. To lessen the burden of these imports, LDCs will need to intensify their efforts for the development of their indigenous energy resources. Changes in the policies followed by governments to attract immediately international oil companies may contribute towards that end. Some least developed countries may have significant oil potential. The

recent discoveries in Yemen Arab Republic and in Democratic Yemen are good examples of what may be possible.

As noted earlier, the LDCs are - generally speaking - poor in energy natural resources. Therefore, it is essential that a major emphasis in energy policy be placed upon efficiency in energy production, distribution and use. The benefits of an efficiency thrust in energy policy is especially well illustrated in the electricity sector.

It is inevitable that electricity usage in the LDC will rise as economic development proceeds. Indeed, if history is any guide, power use will grow considerably faster than income in these countries. Over the 1973-87 period, electricity demand in developing countries as a whole increased 50 per cent faster than GDP; in LDC, however, it rose 300 per cent faster. If the historical relationship between electricity demand and GDP in the LDC persists over the next decade, electrical power use in these countries will reach a level between 50 and 102 billion KWH in the year 2000, depending on whether the economies of LDC grow at their historical rate (2.5 per cent per year) or at a rate similar to that of the whole developing country group (4.5 per cent annually.) At the beginning of the new century then, electricity demand would be 2.6 to 5.2 times larger than now in these countries.

Either figure implies startling requirements for capital to construct the incremental production capacity needed to satisfy demand in the new century. Table 10 quantifies the investment implications of the demand figures. This - what can be termed the "trend" - scenario shows the investment needed between now and the end of the century to provide for the indicated power demand in the year 2000. The investment numbers apply to a situation in which existing levels of efficiency of electricity using devices (lighting systems, electric motors, and electronic devices), current generating equipment utilization rates, and present rates of transmission losses persist through the 1990s. Under this scenario, greater electricity use would be provided for by larger power generating capacity and ancillary equipment. Between roughly 2.3 billion and 5.5 billion dollars (1987 dollars) per year would be needed for investment in power related facilities over the decade. These figures would represent between 12.0 per cent and 22. 5 per cent of all gross fixed capital formation in the group in the year 2000, if investment remains the same share of GDP over the next decade as at the present.

Vigorous policy action relative to the electricity sector in the LDC can significantly reduce these investment needs.

Table 10: Required Investment in the Electricity Sector of the LDC, 1987-2000,

Trend Scenario

	GDP growth rate	
	2.5%/yr	4.5%/yr
Final use in year 2000 (10^9KWH)	49.70	101.00
Internal use and transmission losses (10^9KWH)	11.20	22.80
Required supply (10^9KWH)	60.90	123.00
Net imports (10^9KWH) (1)	0.88	1.77
Utilization rate (%)	25.00	50.00
Required capacity (10^6KW)	22.30	45.20
Required capacity change (including replacement) (10^6KW) (2)	16.20	39.10
Unit cost 10^3 (1987$ per KW) (3)	1.83	1.83
Investment cost total (10^9 1987$)	29.60	71.50
Investment cost per year ($10^9$1987$ per year).	2.28	5.50

Notes: 1. Same percentage of final usage in 2000 as in 1987

2. Replacement estimated at one-third of initial capacity

3. Estimated average cost of generating capacity, transmission, and associated equipment per KW over the period.

Source: Secretariat estimates.

On the demand side, given the very low levels of per capita power use in the LDC currently, there is probably nothing that these countries can do over the next ten years which will reduce very greatly the extreme sensitivity of their electricity demand to GDP. However, some progress in this direction can be made by raising the average level of physical efficiency of the electrical devices employed in them, either by improving the standards of domestic manufacture or by shopping for more energy efficient imports.

The challenge confronting developing countries relative to electricity supply lies in achieving full and efficient utilization of existing capacity. As mentioned, for the group as a whole, the operating rate of electricity generating capacity is only 25 per cent; the corresponding figures for developing countries as a whole and for developed market economies are about 50 and 80 per cent, respectively. Expert opinion in the field seems to agree that the explanation for the relatively high incidence of service interruptions in the LDC lies mainly in inadequate maintenance, lack of spare parts, and operating practices. In addition, transmission and distribution losses dissipate 20 per cent or more of gross electricity production in these countries as compared to the 10 per cent or less regarded as the norm for efficient operation. Technical losses associated with systems design, overloading of lines, and

insufficient maintenance work account for the bulk of such losses.

Table 11 shows the investment implications for the LDC of a scenario in which the physical efficiency of end-use devices is enhanced (lowering the income elasticity of demand by about eight per cent), the capacity utilization rate is raised (to 50 per cent, the present level of all developing countries on the average), and utilities' own power use and transmission losses are reduced (to 15 per cent, also the present level of all developing countries.)

Under this "efficiency" scenario, average annual investment over the decade would be between 0.6 billion and 1.9 billion (1987) dollars, down by roughly three-quarters and two-thirds, respectively, relative to the corresponding figures of the trend case. With the stated improvements in efficiency, investment in the power sector could fall to between 3.1 per cent and 7.9 per cent of all new capital formation in the LDC during the 1990s.

These figures, drawn from only one sector of the energy complex, illustrate what could be accomplished in the LDC by vigorous pursuit of a policy which seeks to enhance the efficiency with which energy is produced and consumed.

Table 11: Required Investment in the Electricity Sector of the LDC, 1987-2000,

Efficiency Scenario

	GDP growth rate 2.5%/yr	GDP growth rate 4.5%/yr
Final use in year 2000 (10^9KWH)	46.10	88.50
Internal use and transmission losses (10^9KWH)	8.15	15.60
Required supply (10^9KWH)	54.20	104.10
Net imports (10^9KWH)	0.81	1.56
Utilization rates (%)	50.00	50.00
Required capacity (10^6KW)	10.30	19.80
Required capacity change (including replacement) (10^6KW)	4.23	13.70
Unit cost 10^3 (1987$ per KW)	1.83	1.83
Investment cost total (10^9 1987$)	7.74	25.10
Investment cost per year ($10^9$1987$ per year).	0.60	1.93

Notes:

1. Same percentage of final usage in 2000 as in 1987
2. Replacement estimated at one-third of initial capacity
3. Estimated average cost of generating capacity, transmission, and associated equipment per KW over the period.

Source: Secretariat estimates.

Suggestions for Further Action

Energy consumption patterns in the LDCs reflect their low levels of economic development, massive poverty and overwhelming dependence on the traditional energy sources. Population growth has already caused adverse effects on the ecological balance which may be expected to deteriorate further unless corrective measures are introduced on time.

Energy supplies for the modern but small sectors of these economies is often characterized by total dependence on oil imports with obvious consequences during periods of high oil prices. During the past two decades the impact of higher oil import bills has been ameliorated to a certain extent by special measures and financial assistance facilities from the United Nations as well as a number of petroleum exporting developing countries. However, the future of these assistance programmes during the 1990s is uncertain although most of the LDCs are expected to require additional oil imports even on assumptions of ~~minimum~~ current levels of economic growth.

Even low rates of economic growth in these countries will be accompanied by higher energy demand and measures to increase energy efficiency and conservation will be necessary both in rural areas where most of the traditional energy sources are consumed and in growing urban areas and modern economic sectors particularly with regard to electricity supply.

In rural areas, traditional energy sources will need replenishment (e.g. reforestation and planting of trees for wood fuel) and more efficient ~~civilization~~ utilization (e.g. improved cook stoves). Ways and means should also be examined for the transfer and application of technologies, including small hydropower plants wind pumps, biogas plants and photovoltaic units. In addition, rural electrification programmes as extensions of existing electricity grid systems should be promoted particularly in rural areas where small scale industries and expanded agricultural output may be feasible.

In the modern sectors of these ~~economies~~ economies special consideration is required in promoting the rehabilitation and improving the efficiency of existing electric systems because of the heavy investments for additional supplies.

Given the importance of oil in the commercial energy consumption pattern of the LDCs, it is imperative that more emphasis be given to ways and means of accelerating exploration and development of indigenous petroleum resources. In this respect it may be noted that several of the LDCs are ~~land~~ land-locked and they often face difficult problems in importing petroleum products; supplies have to be transported in relatively small quantities over long distances on inadequate facilities which add considerably to overall costs. In fact, some of the LDCs have the highest

C.I.F. costs in the world for petroleum products. Many of the LDCs are believed to have a considerable potential but financial resources as well as modern technologies are required for sustained exploration and development programmes. Increased national efforts especially in the organization and re-interpretation of existing petroleum exploration data as well as revisions of petroleum laws and regulations in order to attract more direct investments will need to be supplemented by bilateral and multilateral assistance programmes.

Notes

1. National Account Statistics (N.Y. : United Nations), 1988, preliminary data.

2. All statistics on the energy situations of the LDC presented in this report, unless otherwise noted, are from Energy Statistics Yearbook (N.Y. : United Nations), various issues. It should be noted that the figures do not include Botswana, Lesotho and Tuvalu, for whom data are not available.

3. Hydropower, the other large scale renewable energy source in the LDC, is discussed in the electricity section.

4. Fuelwood in the S.A.D.C.C. area is discussed in "Understanding fuelwood I. A critique of existing interventions in Southern Africa" and "II. Starting with the people", Natural Resources Forum (vol. 13, no.1, Feb. 1989), pp. 1-19.